

maintaining orthodox Christian beliefs, especially as set forth in Scripture. Not only did the theory of a heliocentric universe contradict God's word and challenge the Christian concept of a stable and finite universe, it also deprived human beings of their central place in that universe. The heliocentric theory made humanity seem incidental to God's plan and the heavens seem material and "corruptible." Such an idea did not go unchallenged. The first institutional attack on "the new science" had occurred in 1600, when the Catholic Inquisition tried, condemned, and publicly executed the Italian astronomer Giordano Bruno, who had asserted that the universe was infinite and without center. Bruno had also suggested that other solar systems might exist in space. Sixteen years after Bruno was burned at the stake, Copernicus' writings were put on the Catholic Index of Forbidden Books. Galileo added to the controversy by making his own findings public; and more so because he wrote in the everyday Italian rather than in Latin, the traditional language of Western authority.

More inflammatory still in the eyes of the Church was the publication of Galileo's *Dialogue Concerning the Two Principal Systems of the World* (1632), a fictional conversation between a Copernican and the defenders of the old order, one of whom resembled the pope. Earlier in his career, when it had become evident that his gravitational theories contradicted Aristotle, Galileo had been forced to give up his position as mathematics professor at the University of Pisa. Now he was brought before the Inquisition and, after a long and unpleasant trial, Church officials, threatening torture, forced the aging astronomer to "admit his errors." Legend has it that after publicly denying that the earth moved around the sun, he muttered under his breath, "Eppur si muove" ("But it *does* move!"). Though condemned to indefinite imprisonment, Galileo was permitted to reside—under "house arrest"—in a villa outside of Florence.

Despite unrelenting Church opposition, scientists pressed on to devise new instruments for measurement and new procedures for experimentation and analysis. The slide rule, the magnet, the microscope, the mercury barometer, and the air pump were among the many products of the European quest to calculate, investigate, predict, and ultimately master nature. Seventeenth-century Western scientists investigated the workings of the human eye and explored the genesis and propagation of light, thus advancing the science of optics beyond the frontiers of Islamic and Renaissance scholarship. They accurately described the action of gases and the circulation of the blood. And they devised the branches of higher mathematics known as coordinate geometry, trigonometry, and infinitesimal calculus, by means of which modern scientists might analyze the phenomena of space and motion.

The New Learning

Bacon and the Empirical Method

One of the most characteristic features of the Scientific Revolution was its glorification of the empirical method, a manner of inquiry that depended on direct observation and experimentation. Natural phenomena, argued seventeenth-century scientists, provided evidence from which one might draw general conclusions or axioms, according to a process known as inductive reasoning. The leading spokesman for the new learning was the English scientist and politician Francis Bacon (1561–1626). In 1620, Bacon published his *Novum Organum* ("New Method"), an impassioned plea for objectivity and clear thinking and the strongest defense of the empirical method ever written. "Man, being the servant and interpreter of Nature," wrote Bacon, "can do and understand so much and so much only as he has observed in fact or in thought of the course of Nature: beyond this he neither knows anything nor can do anything."

Bacon argued that human beings must be aided by science and scientific study guided by precise methods. He promoted an objective system of experimentation, tabulation, and record keeping that became the touchstone of modern scientific inquiry. In an era dominated by fervent spirituality, he demanded a separation of religion and science. "In every age," observed Bacon, "Natural Philosophy has had a troublesome adversary . . . namely, superstition, and the blind and immoderate zeal of religion." Unlike earlier humanists, Bacon turned his back on Aristotle and classical science. A prophet of the new learning, he sought to eliminate errors in reasoning derived from blind adherence to traditional sources of authority and religious belief. He condemned all obstacles to the progress of science and championed the idea that knowledge was the most powerful tool for material achievement. In advancing his strategy for the acquisition of knowledge, Bacon warned against four "false notions," or Idols, which, as the following excerpts from his *Novum Organum* illustrate, he condemned as hindrances to clear and objective thinking.

READING 4.8

From Bacon's *Novum Organum*

36

One method of delivery alone remains to us; which is simply this: we must lead men to the particulars themselves, and their series and order; while men on their side must force themselves for a while to lay their notions by and begin to familiarize themselves with facts.

The idols and false notions which are now in possession of the human understanding, and have taken deep root therein,

not only so beset men's minds that truth can hardly find entrance, but even after entrance obtained, they will again in the very instauration¹ of the sciences meet and trouble us, unless men being forewarned of danger fortify themselves as far as may be against their assaults.

39

There are four classes of Idols which beset men's minds. To these for distinction's sake I have assigned names,—calling the first class *Idols of the Tribe*; the second, *Idols of the Cave*; the third, *Idols of the Marketplace*; the fourth, *Idols of the Theatre*.

41

The Idols of the Tribe have their foundation in human nature itself, and in the tribe or race of men. For it is a false assertion that the sense of man is the measure of things. On the contrary, all perceptions as well of the sense as of the mind are according to the measure of the individual and not according to the measure of the universe. And the human understanding is like a false mirror, which, receiving rays irregularly, distorts and discolours the nature of things by mingling its own nature with it.

42

The Idols of the Cave are the idols of the individual man. For every one (besides the errors common to human nature in general) has a cave or den of his own, which refracts and discolours the light of nature; owing either to his own proper and peculiar nature; or to his education and conversation with others; or to the reading of books, and the authority of those whom he esteems and admires; or to the differences of impressions, accordingly as they take place in a mind preoccupied and predisposed or in a mind indifferent and settled; or the like. So that the spirit of man (according as it is meted out to different individuals) is in fact a thing variable and full of perturbation, and governed as it were by chance. Whence it was well observed by Heraclitus² that men look for sciences in their own lesser worlds, and not in the greater or common world.

43

There are also Idols formed by the intercourse and association of men with each other, which I call Idols of the Marketplace, on account of the commerce and consort of men there. For it is by discourse that men associate; and words are imposed according to the apprehension of the vulgar. And therefore the ill and unfit choice of words wonderfully obstructs the understanding. Nor do the definitions or explanations wherewith in some things learned men are wont to guard and defend themselves, by any means set the matter right. But words plainly force and overrule the understanding, and throw all into confusion, and lead men away into numberless empty controversies and idle fancies.

44

Lastly, there are Idols which have immigrated into men's minds from the various dogmas of philosophies, and also from wrong laws of demonstration. These I call Idols of the Theatre; because in my judgment all the received systems are but so many stage-plays, representing worlds of their own creation after an unreal and scenic fashion. Nor is it only of the systems now in vogue, or only of the ancient sects and philosophies, that I speak; for many more plays of the same

kind may yet be composed and in like artificial manner set forth; seeing that errors the most widely different have nevertheless causes for the most part alike. Neither again do I mean this only of entire systems, but also of many principles and axioms in science, which by tradition, credulity, and negligence have come to be received.

Bacon observes that every culture and every age has "worshipped" the Idols. In describing the fallacies that have their foundations in human nature (*Idols of the Tribe*), he points to the fact that human understanding is self-reflective; it functions like a "false mirror," distorting universal truth. Privately held fallacies (*Idols of the Cave*), on the other hand, derive from individual educations and backgrounds. An individual may assert, for instance, that one or another religion is "the true faith," that certain racial or ethnic groups are superior to others, or that women should be judged by a different set of standards than those applied to men. The errors resulting from human association and communication, the *Idols of the Marketplace*, arise, according to Bacon, from an "ill or unfit choice of words." To offer a modern-day example: The use of the noun "mankind" to designate all human beings and the pronouns "she" and "her" to refer to countries and nation-states may work to cultivate a sexist bias in thinking about human history. Finally, Bacon attacks the *Idols of the Theatre*—false dogmas perpetuated by philosophies and institutions in antiquity and in his own time, as well as those that "may yet be composed." It seems likely that Bacon would have regarded the modern doctrines of "divine right monarchy" (see chapter 24) and "separate but equal education" as examples of this category of Idols.

Bacon's clarion call for intellectual objectivity and experimentation inspired the founding in 1645 of the Royal Society of London for Improving Natural Knowledge. The first of many such European and American societies for scientific advancement, the Royal Society has attracted, over the centuries, thousands of members. Their achievements have confirmed one nineteenth-century historian's assessment of Bacon as "the man that moved the minds that moved the world."

While Bacon wrote his scientific treatises in Latin, he used English for essays designed to instruct the average reader. In *The Advancement of Learning* (1605), a sketch of his key ideas concerning methods for acquiring and classifying knowledge, and in the essay *Of Studies*, Bacon demonstrated the masterful use of prose as a tool for theorizing. Written in the poetic prose of the early seventeenth century, *Of Studies* describes the ways in which books serve the individual and society at large. In the excerpt that follows, Bacon eloquently defends reading as a source of pleasure, but, equally important, as a source of practical knowledge and power.

¹Reorganization or renewal.

²A Greek philosopher of ca. 500 B.C.E., who taught that all of nature was in a state of flux.

Descartes and the Birth of Modern Philosophy

Born in France, René Descartes (1596–1650; Figure 22.2) is regarded as the founder of modern Western philosophy and the father of analytic geometry. His writings revived the ancient Greek quest to discover how one knows what one knows, and his methods made the discipline of philosophy wholly independent of theology.

Whereas Bacon gave priority to knowledge gained through the senses, Descartes, the supreme rationalist, valued abstract reasoning and mathematical speculation. Descartes did not deny the importance of the senses in the search for truth, but he observed that our senses might deceive us. As an alternative to inductive reasoning, he championed a procedure for investigation called deductive reasoning. The reverse of the inductive method, the deductive process began with clearly established general premises and moved toward the establishment of particular truths. Among the rules Descartes set forth were the following: Never accept anything as true that you do not clearly know to be true; dissect a problem into as many parts as possible; reason from simple to complex knowledge; and finally, draw complete and exhaustive conclusions. In the *Discourse on the Method of Rightly Conducting the Reason and Seeking for Truth in the Sciences*, perhaps the most important of all his philosophic works, Descartes began by systematically calling everything into doubt. He then proceeded to identify the first thing that he could not doubt—his existence as a thinking individual. This one clear and distinct idea of himself as a “thinking thing,” expressed in the proposition “*Cogito, ergo sum*” (“I think, therefore I am”), became Descartes’ “first principle” and the premise for all of his major arguments.

For Descartes, the clear and unbiased mind was the source of all natural understanding. “Except [for] our own thoughts,” he insisted, “there is nothing absolutely in our power.” Having established rational consciousness as the only sure point of departure for knowledge, Descartes proceeded to examine the world. He made a clear distinction between physical and psychical phenomena, that is, between matter and mind, and between body and soul. According to this dualistic model, the human body operates much like a computer, with the immaterial mind (the software)



Figure 22.2 Frans Hals, *Portrait of René Descartes*, 1649. Oil on wood. 7½ × 5½ in. Royal Museum of Fine Arts, Copenhagen.

“informing” the physical components of the body (the hardware). The Cartesian view of the human mind as a thinking substance distinct from the human body dominated European philosophic thought until the end of the nineteenth century and still has some strong adherents today.

READING 4.10

From Descartes' *Discourse on Method* (Part IV)

... I do not know that I ought to tell you of the first meditations there made by me, for they are so metaphysical and so unusual that they may perhaps not be acceptable to everyone. And yet at the same time, in order that one may judge whether the foundations which I have laid are sufficiently secure, I find myself constrained in some measure to refer to them. For a long time I had remarked that it is sometimes requisite in common life to follow opinions which one knows to be most uncertain, exactly as though they were indisputable, as has been said 10 above. But because in this case I wished to give myself entirely to the search after Truth, I thought that it was necessary for me to take an apparently opposite course, and to reject as absolutely false everything as to which I could imagine the least ground of doubt, in order to see if afterwards there remained anything in my belief that was entirely certain. Thus, because our senses sometimes



- 1626 Francis Bacon uses snow in experiments to refrigerate chickens
- 1637 René Descartes introduces analytic geometry
- 1656 Christian Huygens develops the first accurate pendulum clock
- 1660 Anton van Leeuwenhoek discovers microscopic protozoa

deceive us, I wished to suppose that nothing is just as they cause us to imagine it to be; and because there are men who deceive themselves in their reasoning and fall into 20 paralogisms,¹ even concerning the simplest matters of geometry, and judging that I was as subject to error as was any other, I rejected as false all the reasons formerly accepted by me as demonstrations. And since all the same thoughts and conceptions which we have while awake may also come to us in sleep, without any of them being at that time true, I resolved to assume that everything that ever entered into my mind was no more true than the illusions of my dreams. But immediately afterwards I noticed that whilst I thus wished to think all things false, it was 30 absolutely essential that the "I" who thought this should be somewhat, and remarking that this truth "*I think, therefore I am*" was so certain and so assured that all the most extravagant suppositions brought forward by the sceptics were incapable of shaking it, I came to the conclusion that I could receive it without scruple as the first principle of the Philosophy for which I was seeking.

And then, examining attentively that which I was, I saw that I could conceive that I had no body, and that there was no world nor place where I might be; but yet that I could 40 not for all that conceive that I was not. On the contrary, I saw from the very fact that I thought of doubting the truth of other things, it very evidently and certainly followed that I was; on the other hand if I had only ceased from thinking, even if all the rest of what I had ever imagined had really existed, I should have no reason for thinking that I had existed. From that I knew that I was a substance the whole essence or nature of which is to think, and that for its existence there is no need of any place, nor does it depend on any material thing; so that this "me," that is to say, the 50 soul by which I am what I am, is entirely distinct from body, and is even more easy to know than is the latter; and even if body were not, the soul would not cease to be what it is.

After this I considered generally what in a proposition is requisite in order to be true and certain; for since I had just discovered one which I knew to be such, I thought that I ought also to know in what this certainly consisted. And having remarked that there was nothing at all in the statement "*I think, therefore I am*" which assures me of having thereby made a true assertion, excepting that I see 60 very clearly that to think it is necessary to be, I came to the conclusion that I might assume, as a general rule, that the things which we conceive very clearly and distinctly are all true—remembering, however, that there is some difficulty in ascertaining which are those that we distinctly conceive.

Following upon this, and reflecting on the fact that I doubted, and that consequently my existence was not quite perfect (for I saw clearly that it was a greater perfection to know than to doubt), I resolved to inquire 70 whence I had learnt to think of anything more perfect than I myself was; and I recognised very clearly that this conception must proceed from some nature which was really more perfect. As to the thoughts which I had of many other things outside of me, like the heavens, the earth, light, heat, and a thousand others, I had not so much difficulty in knowing whence they came, because, remarking nothing in them which seemed to render them

superior to me, I could believe that, if they were true, they were dependencies upon my nature, in so far as it possessed some perfection; and if they were not true, that 80 I held them from nought, that is to say, that they were in me because I had something lacking in my nature. But this could not apply to the idea of a Being more perfect than my own, for to hold it from nought would be manifestly impossible; and because it is no less contradictory to say of the more perfect that it is what results from and depends on the less perfect, than to say that there is something which proceeds from nothing, it was equally impossible that I should hold it from myself. In this way it could but follow that it had been placed in me by a Nature which was 90 really more perfect than mine could be, and which even had within itself all the perfections of which I could form any idea—that is to say, to put it in a word, which was God. . . .

Religion and the New Learning

The new learning, a composite of scientific method and rational inquiry, presented its own challenge to traditional religion. From "self-evident" propositions, Descartes arrived at conclusions to which empirical confirmation was irrelevant. His rationalism—like Plato's—involved a process of the mind independent of the senses. Reasoning that the concept of perfection ("something more perfect than myself") had to proceed from "some Nature which in reality was more perfect," Descartes "proved" the existence of God as Absolute Substance. Since something cannot proceed from nothing, argued Descartes, the idea of God held by human beings must come from God. Moreover, the idea of Perfection (God) embraces the idea of existence, for, if something is perfect, it must exist. Raised by Jesuits, Descartes believed in the existence of a Supreme Creator, but he shared with many seventeenth-century intellectuals the view that God was neither Caretaker nor Redeemer. Indeed, Descartes often identified God with "the mathematical order of nature." The idea that God did not interfere with the laws of humanity and nature was central to deism, a system of thought advocating a "natural" religion based on human reason rather than revelation. Deists purged religion of superstition, myth, and ritual. They viewed God as a master mechanic who had created the universe, then stepped aside and allowed his World-Machine to run unattended.

Unlike Bacon, Descartes did not envision any conflict between science and religion. He optimistically concluded that "all our ideas or notions contain in them some truth; for otherwise it could not be that God, who is wholly perfect and veracious, should have placed them in us." Like other deists of his time, Descartes held that to follow reason was to follow God.

In Amsterdam, a city whose reputation for freedom of thought attracted Descartes—he lived there between 1628 and 1649—the Jewish philosopher Baruch

¹Fallacious arguments.

stop